Rehabilitation of a patient receiving a large-resection hip prosthesis because of a phosphaturic mesenchymal tumor

Maurizio Lopresti,[1] Primo Andrea Daolio,[2] Jacopo M. Rancati,[3] Nicoletta Ligabue,[1] Arnaldo Andreolli,[4] Lorenzo Panella[3]

[1]Oncologic Rehabilitation Centre, Gaetano Pini Orthopedic Institute, Milano; [2]Oncologic Surgery Centre, Gaetano Pini Orthopedic Institute, Milano; [3]Department of Rehabilitation and Functional Recovery, Gaetano Pini Orthopedic Institute, Milano; [4]Department of Rehabilitation and Functional Recovery, Luigi Sacco Hospital, Milano, Italy

Abstract

Tumor-induced osteomalacia is an osteomalacic syndrome caused by a mesenchymal origin's tumor. The diagnostic procedure takes time and extensive investigations because of the characteristics of these tumors usually small dimensioned, slowly growing, non-invasive and therefore hard to locate. The differential diagnosis is determined by a bone biopsy. Tumor's surgical removal is the treatment of choice that leads up to a complete regression of the oncogenic malacic syndrome. In the clinical course of these patients we can often see multiple episodes of pathological fractures, peri-prosthesis fractures or prosthesis mobilizations, due to the malacic picture: surgical procedures are often widely demolitive and requires mega-prosthetic implant. The rehabilitative procedure used to take care of these patients, is described in the following case report and based on the collaboration between surgical and rehabilitative teams. Rehabilitative pathway after hip mega-prosthesis does not find references in medical literature: the outcomes analyzed in this case report demonstrate the efficacy of the rehabilitative procedure applied.

Introduction

Tumor-induced osteomalacia (TIO) is a rare paraneoplastic disease in which causative tumor (generally of mesenchymal origin) gives rise to an oncogenic osteomalacial syndrome, whose underlying pathogenetic mechanism is related to the tumor's production of a phosphaturic factor that reduces the renal reabsorption of phosphates and causes renal phosphate leak.

The tumors are generally small, slowly growing and non-invasive. Most are localized at long bone level, but they are frequently impossible to locate and the correct diagnosis may take 5-7 years.[1-3]

Clinical picture and diagnostic work-up

The clinical picture is characterized by non-specific symptoms, such as hyposthenia, worsening myalgia and bone pain (mainly affecting load-bearing areas), and gait alterations (anserine gait). Until a correct diagnosis has been made patients usually undergo symptomatic treatments without success. Those patients history is characterized by numerous pathological fractures, periprothesical fractures and prothesis mobilizations. The elective surgical treatment of TIO is tumor resection, which normally leads to a complete regression of the osteomalacial syndrome. The consequent rehabilitation treatment must consider the complexity of the clinical-functional picture of the patient, especially if a substitution megaprothesis surgery is needed.[4-8]

Case Report

The clinical history of PM (born in 1945) began in 2000, when she consulted her General Practitioner because of widespread costal and vertebral pain of no known traumatic cause, mainly localized in the dorso-lumbar region. The x-ray findings were negative, and she was prescribed non-steroidal anti-inflammatory drugs treatment without receiving any benefit.

The picture remained unchanged until 2003, when bone scintigraphy revealed areas of the pathological accumulation of the radio-labeled tracer in the proximal third of the right femoral diaphysis, some costal arches and an area of bone rarefaction in the right humeral diaphysis. Further laboratory tests revealed hypocalcemia, and so the patient started pharmacological treatment with bisphosphonates, calcium and vitamin D3 for suspected advanced osteoporosis.

Because of the persistence of the painful symptoms, a bone biopsy of the humeral lesion was performed; that led to the diagnosis of a *spindle cell mesenchymal tumor, morphologically arising from a glomus tumor*. Given the suspicion of TIO, the patient underwent octreotide scintigraphy, which revealed increased tracer uptake at the level of the medio-proximal third of the right humerus.

In January 2005, she underwent a first surgical intervention that involved curettage of the lesion, an autograft from the ipsilateral tibia, and a bone biopsy, thus allowing the final diagnosis of a phosphaturic mesenchymal tumor.

As a result of an accidental fall in July 2005, the patient suffered a subcapital fracture of the right femur and a bifocal fracture of the previously treated right humeral diaphysis. Laboratory tests once again revealed hyper-phosphaturic hypophosphatemia, and so she therefore underwent dual surgery involving the implantation of a bi-articular endoprosthesis cemented to the femur, an osteosynthesis of the humerus with a screwed plate and then sent to the rehabilitation department.

In 2007, worsening humeral pain associated with disease recurrence (confirmed by means of instrumental investigations) led to the patient being readmitted to hospital to undergo to a segmental resection of the diseased humerus and its reconstruction by means of the insertion of a cemented 8-holed plate which, soon afterwards, were replaced with a new ipsilateral tibial graft in order to provide medial reinforcement after a distal screws displacement (Figure 1A).

The patient's clinical condition remained stable until April 2009 when, during an outpatient follow-up examination, she complained pain in her right hip radiating to the knee and accentuated by weight bearing. X-rays revealed loosening of the femoral stem with bone reabsorption around the cemented area. The prosthetic stem was revised and a new femoral stem was implanted (Figure 1B).

In March 2010 the pain in the right hip and femur reappeared and subsequent x-rays showed partial progressive subsidence of the prosthetic stem to a depth of about 2.5 cm (Figure 1C). Furthermore, examinations of the humerus revealed the partial mobilization of

Correspondence: Lorenzo Panella, Department of Rehabilitation and Functional Recovery, Gaetano Pini Orthopedic Institute, via Isocrate 19, 20126 Milano, Italy.
E-mail: Lorenzo.Panella@gpini.it

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Table 1. Rehabilitation protocol for patients receiving a large-resection hip prosthesis.

Gaetano Pini Orthopedic Institute Rehabilitation protocol for patients receiving a large-resection hip prosthesis	
Week	**Program**
1	After the hip replacement with a large-resection prosthesis, patients require 7-8 days of lying down. They are often receiving analgesic treatment because of the pain caused by the extensive surgery. During these days, the rehabilitation therapy consists of exercises aimed at: - preventing venous and lymphatic pooling; - preventing possible respiratory complications; - maintaining the tone and trophism of the principal anti-gravitational muscles of the operated limb (the gluteal muscles from day 3-4) by means of their isometric activation; - stimulating the spontaneous motor activity and strength of the limbs not involved in the surgery. The operated limb is held in a splint, which is only removed during nursing and rehabilitation activities.
2	Beginning from the second week, the patient is gradually weaned from the splint, which is replaced by a Newport hip orthosis locked in position 0°. The patient and/or caregiver are instructed in the hygiene and correct wearing of the orthosis, with particular attention being given to points of contact with the skin in order to avoid any decubitus. The orthosis can also be worn over clothing. If the patient is clinically stable, it is already possible to begin making positional changes from bed to wheelchair, which must take place with the hip extended. In order to overcome this problem, the transfers are made from the operated limb side of the bed, with the hip supported by an assistant in order to prevent the rotations that the orthosis is incapable of controlling. The wheelchair must naturally be fully reclining in order to allow the patient to avoid flexing the hip. If the patient's clinical condition allows, it is possible to proceed to the re-education of standing with the aid of an assistant and anterior support (parallel bars or a walking frame).
3	Beginning from week 3, clinically stable patients can be transferred to the Oncological Rehabilitation Unit, where they can start the intensive rehabilitation program: the capacities acquired during the training in making positional changes are consolidated and, as soon as possible, exercises designed to prepare the patient for walking are added using a 3-stage technique. The forward movement of the operated limb is initially compensated for by sagittally oscillating the trunk in order to avoid flexion-extension movements of the hip. In case of difficulty in swinging the operated limb, it is possible to use a contralateral platform. Weight bearing is gradually permitted depending on the type of prosthesis and as indicated by the surgeon. The therapeutic exercises proposed to the patient are intended to mobilize the knee of the operated limb early (keeping the hip extended) and consolidate the objectives described in points 3 and 4 of week 1.
4	From week 4, the orthosis is gradually released until reaching 90° of flexion; this takes about 7-10 days depending on the pain felt by the patient. Having achieved the goal, it is possible to proceed with maneuvers aimed at the recovery of ROM by means of exercises that can be also be done without the orthosis, and the recovery of a sitting posture. The standing and gait training exercises are continued, and progressive exercises of assisted active mobilization with the hip in abduction are started.
5 to 7	The proposed exercises have the aim of consolidating the re-acquired abilities by gradually reducing the assistance of the caregiver and the breadth of the base of support when standing and walking (with elbow crutches progressively replacing the walking frame). Functional exercises are started in preparation of the return home, including stairs training, re-education in ADL, and the postural movements involved in entering and leaving a car.
8	From the eighth week, it is possible to begin weaning the patient from the orthosis during the therapeutic exercises. By week 10, the orthosis is removed completely, even during sleeping hours. Once the orthosis has been removed, it is possible to begin hydrokinesitherapy provided that the condition of the surgical wound allows it, and the patient has acquired confidence in walking and going up and down stairs using elbow crutches (in order to be able to enter the rehabilitation baths safely).
Notes	*Complete weight bearing:* Complete weight bearing is normally reached within 8-10 weeks, although the use of crutches may be indicated for a longer period of time depending on articular stability. *Contraindications and complications:* In general, the movements that should be avoided are the same as those to be avoided in the case of a classic hip prosthesis, although there may be others related to the loss of muscle mass that need to be evaluated case by case. If the patient needs to undergo radio- or chemotherapy, the clinical course of the rehabilitation may significantly vary.

ROM, range of motion; ADL, activity daily living.

Table 2. Scores recorded during the period of rehabilitation (admission and discharge) and after six months' follow-up.

Post-surgery day	ROM (flexion)	VAS	Barthel	TESS (%)	TESS (%)	MTSS	MTSS (%)
Admission (21)	0	5	57	38	7.75	4/30	13.33
Discharge (60)	0-90°	2	81	87	50	8/30	26.66
Follow-up (180)	0-90°	0	98	101	62	17/30	56.66

ROM, range of motion; VAS, visual analogue scale; TESS, Toronto extremity salvage score; MTSS, Musculoskeletal Tumor Society scale.

the proximal screws (Figure 1D).

In September 2010 the patient underwent to a new revision surgery, and due to a poor cortical bone resistance a 22 cm resection from the apex of the great trochanter were executed and a large-resection modular prosthesis was implanted. The stem was cemented and Trevira mesh was used proximally to attach the extra-rotary thigh musculature in order to reconstruct the articular capsule (Figure 1E-F). The postoperative course was normal and the patient started rehabilitation training as per *ad hoc* protocol (Table 1).

The functional outcomes and efficacy of the rehabilitation program were evaluated using the following scores (Table 2): range of motion, visual analogue scale, Barthel's index, Toronto extremity salvage score, and Musculoskeletal Tumor Society scale.[9-11] Since the 1st week of permanence in the G. Pini Oncological Orthopedic Surgery the patient started distal mobilization exercises of the treated limb to prevent venous and lymphatic pooling, selective isometric exercises for maintaining the tone and trophism of the main anti-gravitational muscles (gluteal muscles from day 3-4), and self-mobilization and strengthening exercises of the body districts not involved in the surgery. From the 2nd week, the patient has substituted a lower limb splint with a Newport hip orthosis (Figure 2) locked in position 0°. The patient and her relatives were trained in correct wearing of the support by technical staff and nurses.

From day 12, the by now clinically stable patient started the training for the recovery of orthostasis and short-distance transfers (from bed to wheelchair) with no weight bearing. The back of the wheelchair used was fully reclined in order to avoid the patient to flex the hip. It was necessary to make these movements for keeping the hip in position 0°, the on-bed transfer has been made on the operated limb side, with maximum assistance of the therapist in order to avoid any rotation of the lower limb.

Together with the re-education of postural transfers, the patient was trained in how to reach and maintain a standing position with the support of a 4-legged walking frame (to guarantee the greatest stability) with the treated limb just touching the floor.

From the 3rd week were added exercises using a 3-stage technique. The forward movement of the limb was compensated by a sagittal oscillation of the trunk to avoid hip flexion-extension. In order to allow the patient to adequately oscillate the operated limb without flexing the hip, she was initially asked to provide contralateral support in an equine manner (to avoid a swinging forward movement) balanced by the counter-oscillation of the trunk on the coronal plane.

The therapeutic exercises proposed to the patient in a prone lying position had the aim of consolidating the objectives set from the 1st week and mobilizing the knee while keeping the hip extended. In addition to guaranteeing the early recovery of walking abilities, the knee mobilization exercises had the aim of improving the tone and trophism of the femoral quadriceps and the stiffness of the ilotibial band, which, as this was the site of surgical access, was at risk of adherences that could compromise the knee movement.

On the 21st day after surgery, the patient was transferred to Gaetano Pini Rehabilitation Centre where the orthosis was gradually released (starting on post-surgery day 30) until it reached 90° of flexion by means of passive and assisted active sagittal mobilization under the pain threshold. She also performed progressive exercises of assisted active mobilization with the hip in abduction, and strengthening exercises for her right arm overloaded by the heavy use of walking aids.

The walking re-education exercises continued with the gradual replacement of the walking frame by elbow crutches: her gait showed slight abduction of the hip (which gradually regressed) during both the advancement and fleetingly light weight-bearing phases.

Once capable of walking autonomously for albeit short distances, the patient was given functional exercises in preparation for her return home, including stairs training, re-education in the activities of daily living, and the postural movements involved in entering and leaving a car. A few days before being discharged, she began the weaning from the orthosis and started step training exercises in water (with the water up to her chest - 25% of her weight borne by the limb). This hydrokinetic therapy gave the treated limb an important proprioceptive stimulus in terms of weight bearing without aids, but in absolute safety conditions. Throughout her stay in the rehabilitation center, the surgical wound was treated with manual debridement.

When she was discharged 60 days after surgery, she was able of walking autonomously for long distances with the aid of two elbow crutches. She was instructed to continue the exercises at home in order to maintain and consolidate her acquired abilities. At the orthopedic follow-up examination 2 weeks after discharge, she was given permission to walk using only the contralateral crutch.

The 6-months physiatric follow-up examination showed a clear improvement in the functional outcome measures (Table 2).

Discussion

The tumor-induced osteomalacia is a paraneoplastic syndrome, which causes osteomalacy, causing small dimension lesions, characterized by a slow growth without any specific anatomic localization. Those lesions can lead to pathologic fractures, which, if treated without removing the neoformation or with a partial excision, may recur subsequently, along with loosening or displacement of prothesis components. The lesions can be studied with x-rays, computed tomography, magnetic resonance imaging, concreotide tri-phasic *whole-body* scintigraphy and F-18 fluorodeoxyglucose positron-emission tomography. Having confirmed the nature of the lesion, treatment of a phosphaturic-secreting mesenchymal tumor is its surgical removal with broad margins by means of unconventional techniques such as a large resection and prosthetic implantation.[12]

In absence of a correct diagnosis, the rehabilitation treatment of patients with TIO was initially based on reducing/containing the painful symptoms and asthenia, and is naturally not beneficial. For this reason, the worsening pain and progressive loss of functional capacities can reduce the compliance with treatment and affect patient mood.[13]

The loss of bone mass due to this type of tumor is not associated with the muscle tissue loss, but the overall balance is usually characterized by asthenia of the main anti-gravitational, stabilizing and mobilizing muscles as a result of long pre- and post-surgery periods of immobility. The adherence of scars due to repeated revision surgeries can also give rise to articular and functional limitations (Figure 3) unless they are appropriately treated.

The time necessary to resume everyday living activities is longer than after conventional surgery, and requires specific techniques strictly related to the highly invasive surgery. The requirements are: i) special care during the first four weeks of rehabilitation and, in any case, a longer period of hospitalization that that required after a normal hip replacement procedure (the protocol lasts of 60 days); ii) the use of specific aids (hip orthosis and reclinable wheelchair) and training the patient and caregivers by nurses and technical staff in how to use them; iii) learning specific movement techniques to get an early recovery of a standing position and making positional changes aimed at protecting the implant stability while developing the patients residual functional capacities also by means of compensatory strategies; iv) particular care in treating the surgical wounds, which are more extensive than those associated with traditional prosthetic implants.

Conclusions

Tumor-induced osteomalacia is a paraneo-

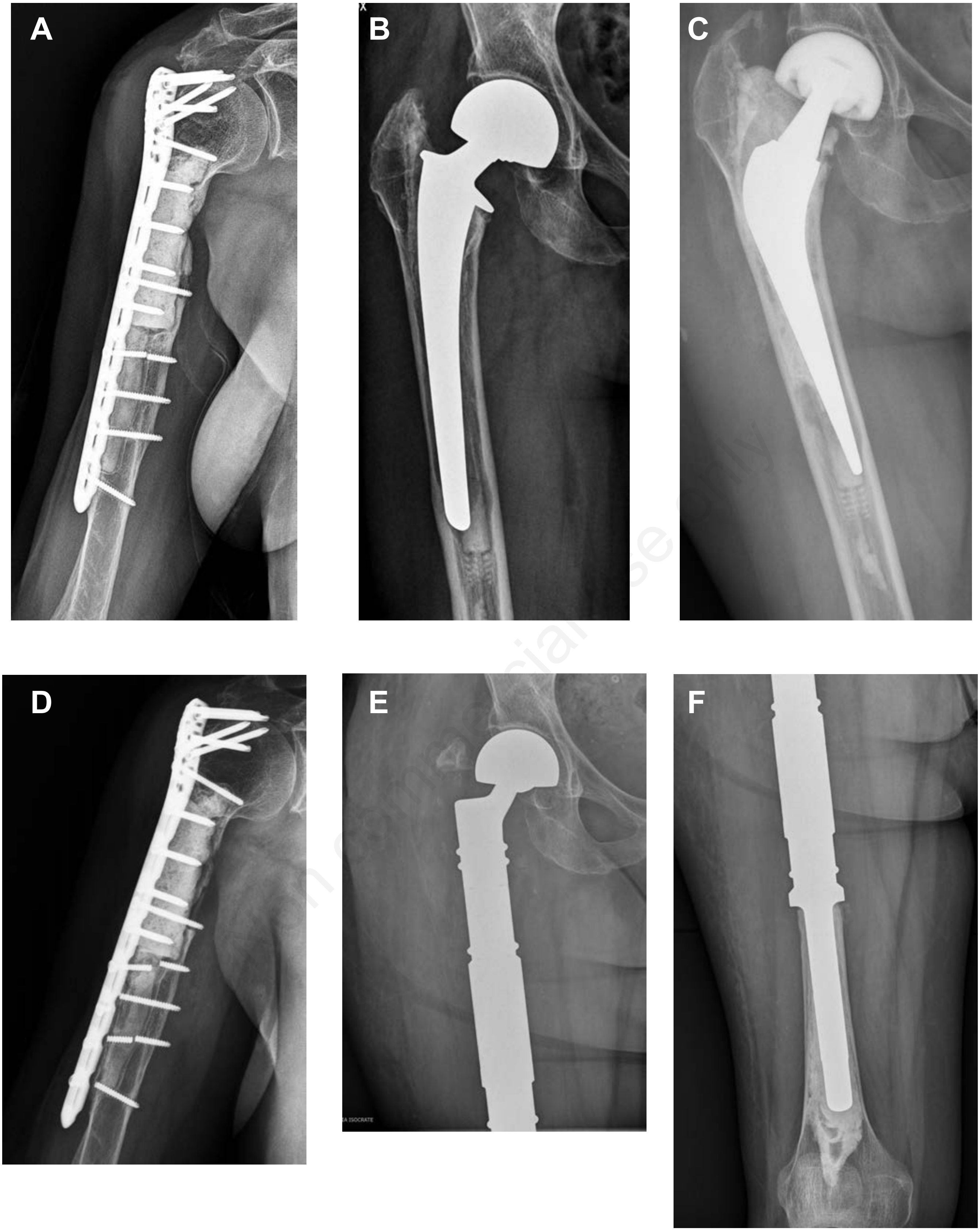

Figure 1. X-ray: A) Right humeral osteosynthesis; B) First prosthetic implant with signs of stem mobilization; C) Second prosthetic implant with subsidence; D) Signs of mobilization and breakage of the right humeral screws; E and F) Large-resection prosthesis (proximal and distal femur).

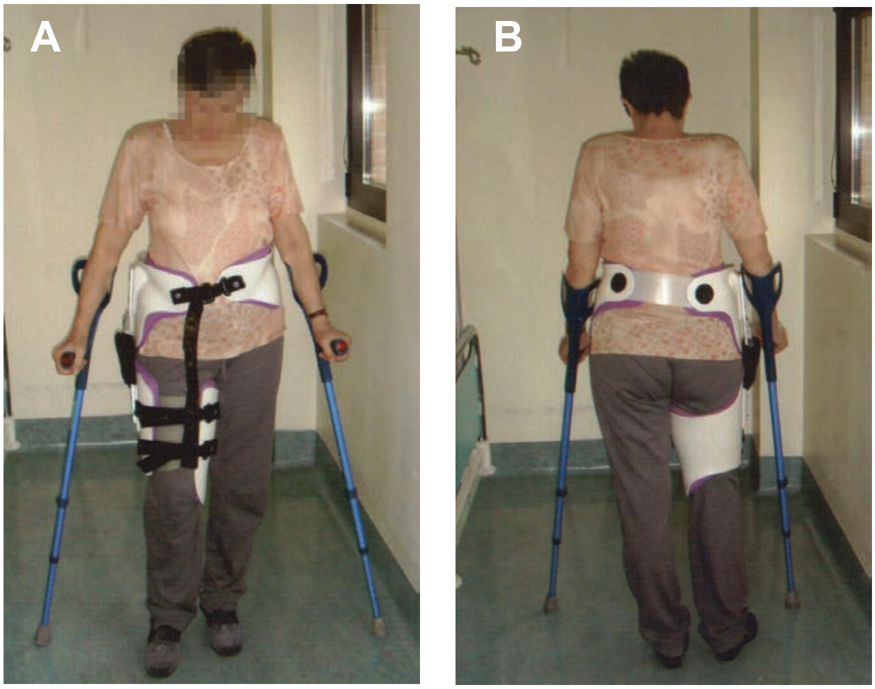

Figure 2. Newport hip orthosis: A) anterior and B) posterior views.

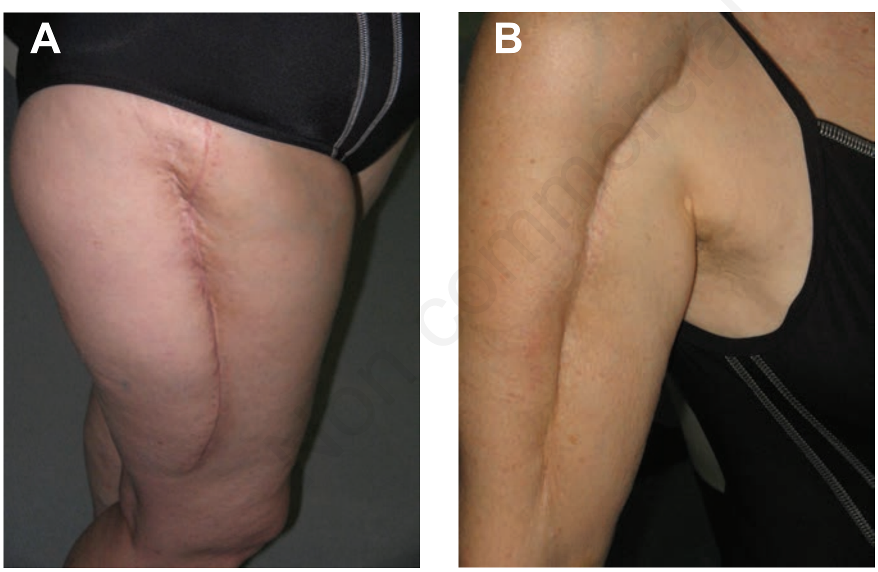

Figure 3. A and B) Scars left by the surgical wounds.

plastic syndrome difficult to be diagnosed. A close cooperation between surgical and rehabilitative teams makes the diagnosing process easier. Surgery is the treatment of choice. The functional pictures which result are often complex for the long diagnostic-therapeutic pathway and for the highly invasive surgery needed. The scientific research has not validated any standard rehabilitation protocol or any specific guidelines yet. The protocol developed at the Gaetano Pini Orthopedic Institute with the collaboration of the rehabilitation and orthopedic team has demonstrated to be effective in the case above described.

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